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Phosphorus and Potassium Fertilizer Placement for Corn and Soybeans Managed with No-Till and Chisel-Disk Tillage

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Abstract
A long-term study was initiated in 1994 to evaluate phosphorus (P) and potassium (K) fertilizer rates and placement methods for corn and soybeans managed with no-till and chisel-plow tillage. No-till management resulted in little or no incorporation of residue and fertilizer into the soil. Broadcast fertilization has generally been inefficient with no-till because both nutrients accumulate near the soil surface. Subsurface banding of P and K fertilizers, however, can be more effective.

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Introduction

A long-term study was initiated in 1994 to evaluate phosphorus (P) and potassium (K) fertilizer rates and placement methods for corn and soybeans managed with no-till and chisel-plow tillage. No-till management resulted in little or no incorporation of residue and fertilizer into the soil. Broadcast fertilization has generally been inefficient with no-till because both nutrients accumulate near the soil surface. Subsurface banding of P and K fertilizers, however, can be more effective.

Procedures

The study consisted of four separate trials: P for corn, P for soybeans, K for corn, and K for soybeans. Both crops were grown in rotation on adjacent areas of Marshall soil by alternating crops each year. Tillage and fertilization treatments were applied for both crops, which were planted with a 30-in. row spacing. Cornstalks of plots managed with chisel plow tillage were chisel-plowed in the fall and field-cultivated or disked in the spring. Soybean residues were field-cultivated in spring. The fertilizer placement methods were broadcast, deep-band, and band with the planter until 2001 when deep-band treatments were discontinued (see previous reports). The broadcast fertilizers were applied in the fall. Planter bands are applied about 2 in. below and 2 in. beside the seeds. Fertilizer treatments until 2001 included a check, and rates of P or K to supply about one-half the estimated maintenance needs (28 lb P_2O_5/acre or 35 lb K_2O/acre), and full maintenance (56 lb P_2O_5/acre or 70 lb K_2O/acre). Since 2002, new broadcast P and K treatments (112 lb P_2O_5/acre or 140 lb K_2O/acre) began to be applied to plots that in the past had received maintenance fertilizer rates one-half deep banded and one-half with the planter.

Summary Results

Tillage Effects. Results for the last two years showed that on average soybean yield was 2 bushels/acre higher with no-till and that corn yield was 2 bushels/acre higher with tillage. In the past, soybean yield has not differed between tillage systems or has differed by less than 2 bushels/acre. Corn yield has been about 4 bushels/acre higher with tillage on average. Only yields for 2001 and 2002, both dry years, differed from the general trend, when yields of both crops were higher with no-till than with tillage.

Phosphorus Fertilization Effects. Small and inconsistent yield responses to P fertilization began to be observed in 2001. Soil-test P was in the optimum class in 1994, and by fall 2002, soil P of the check plots had decreased to a value between optimum and low. The average soybean response during the last two years was small (Table1), although the response was larger with no-till
(4.7 bu/acre) than with tillage (2.2 bu/acre). In contrast, the corn response was significant in the last two years averaging 14.5 bushels/acre with no-till and 12.1 bushels/acre with tillage. The recent larger responses are reasonable because soil-test P of the check plots continued decreasing into the low soil-test class.

The P application method has not affected crop

yields significantly in the past, but during the last two years there was a small advantage for the planter-band placement for corn managed with both tillage systems (4.4 bu/acre on average). Banded P has greatly increased early growth of crops managed with both tillage systems.

Potassium Fertilization Effects. Potassium fertilization has resulted in small and inconsistent yield increases over time. No yield response was expected in the early years because initial soil-test K was high. Soybean showed no response to K in the last two years (Table 1). Corn has shown small and inconsistent yield response to K in the past, although during the last two years the response averaged 7.3 bushels/acre with no-till and 2.1 bushels/acre with tillage. The recent larger corn responses are reasonable because soil-test K of the check plots had decreased into the optimum soil-test class. Only maintenance fertilization is recommended for this class.

The crop response to K placement methods has been small and inconsistent across years and tillage systems. Initially there was a very small advantage for deep-band K. Results for other research farms and farmers' fields have shown clearer advantage of deep-band K for no-till corn and soybean in some years. Results for the last two years in Table 1 show a small advantage of planter-band K for corn that was similar for both tillage systems (4.7 bu/acre on average). This response was about the same the for the two annual K fertilizer rates that were compared.

Conclusions

Tillage has not had large and consistent effects on soybean yield, although in recent years yield has been slightly higher with no-till than with chisel-disk tillage. The long-term average corn yield has been higher with tillage, but no-till corn yielded more in years with deficient soil moisture.

Grain yield responses to P and K began to be observed during the last two years because soil-test values of the check plots has decreased into the low class for P and into the optimum class for K. The fertilizer placement method has not affected corn or soybean yield significantly or consistently. However, during the last two years we observed a slightly higher corn yield that was not observed before when P and K were banded with the planter compared with broadcast application. These results need to be confirmed in the future as crop responses to fertilization may become larger and more consistent.

Table 1. Average effects of tillage, fertilizer placement method, and annual phosphorus and potassium rates on corn and soybean grain yields during 2004 and 2005.

	Phosphorus treatments (lb P_2O_5/acre)						Potassium treatments (lb K_2O/acre)					
		Broadcast			Planter band			Broadcast			Planter band	
Tillage	Check	28	56	112	28	56	Check	35	70	140	35	70
	Soybean grain yield (bu/acre)											
Chisel	60.3	62.7	60.6	65.4	61.9	62	55.7	55.8	57.6	55.4	56.5	56.3
No-till	58.5	64.1	64.2	63.7	61.3	62.6	62.9	61.2	61.8	63	62.5	61.9
	Corn grain yield (bu/acre)											
Chisel	211	222	218	226	225	226	211	210	212	208	218	215
No-till	204	216	218	221	221	220	206	217	207	210	218	214